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AUTHOR Ott, Mary Diederich; Markewich, Theodore S.
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ABSTRACT

Logit analysis coupled with the BMDP4F computer program (Brown, 1983) was used to derive an appropriate model for the study of student retention and graduation. The model was then applied to graduate student retention and graduation data from the University of Maryland, College Park (UMCP). Logit analysis is a method of determining what effects need to be entered into a model for adequately predicting the value of a categorical dependent variable and involves independent variables that are all categorical. The BMDP4F log-linear analysis procedure was used in the application on the UNIVAC 1180 to determine which independent variables and interactions were necessary to predict retention. The UMCP study was concerned with identifying predictors of (1) graduation within a specific number of years since admission and (2) retention each year after entry for students registering for master's or doctoral programs during 1977-1979. Results included the following: the difference in predicted retention rates among academic divisions at the doctoral level may be related to differences in the perceived advantage accruing to the completion of a doctorate versus the personal and financial sacrifice involved in continued study; full-time rather than part-time status at entry may be related to greater goal commitment and may result in a higher degree of social integration; and the lack of a significant relationship between age and retention in graduate school is similar to the conclusion of Pantages and Creedon (1978) for college attrition. The results of the UMCP study are compared with other studies. Two appendices include a list of graduate programs by graduate division and a table giving characteristics of sample by level of program. Tables are included. Contains 33 references. (SM)

LOGIT ANALYSIS OF GRADUATE STUDENT RETENTION AND GRADUATION

Mary Diederich Ott

and

Theodore S. Markewich

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Office of Institutional Studies
The University of Maryland
College Park
College Park, MD 20742

LOGIT ANALYSIS OF GRADUATE STUDENT RETENTION AND GRADUATION

Although there have been many studies of the retention of college students, in recent years few studies have been published regarding the retention of graduate students (Loeb & Duff, 1974; Lunneborg & Lunneborg, 1973; Naylor & Sanford, 1982; Solmon, 1973, 1976). The main contributions of this paper are (1) the development of a logit model in a form suitable for application to the study of student retention and graduation, and (2) the application of this model to graduate student retention and graduation data from a major university.

In retention studies, the methods of analysis have included discriminant analysis (Chapman & Hutcheson, 1982; Stork & Berger, 1978; Terenzini & Pascarella, 1977), multiple regression (Aitken, 1982; Bean, 1980; Kohen, Nestel & Karmas, 1978; Lunneborg & Lunneborg; Munro, 1981; Peng & Fetters, 1978; Terenzini & Pascarella, 1978), and other methods, such as probit analysis (Rumberger, 1983), chi-square analysis (Loeb & Duff), and simple tabulations (Naylor & Sanford). However, if the dependent variable in a retention study is dichotomous (e.g., Y=1 if retained, Y=0 if not retained), discriminant analysis and multiple regression are not the most appropriate methods of analysis.[1]

In our study, the independent variables as well as the dependent variable were all categorical variables. For this type of problem, logit analysis is appropriate.[2] Logit analysis, like regression analysis, can be used to determine which independent variables and interactions are required to describe retention or graduation. Logit analysis also enables one to develop predicted probabilities of retention or graduation for each combination of the independent variables. Although logit analysis is discussed in texts such as

those by Bock (1975), Goodman (1978), and Haberman (1978), logit analysis has rarely been reported in published educational research. Exceptions are articles by Burnett & Parmley (1982), Marks (1975), and Rolph, Williams, & Lee (1979). One reason for this scarcity of reports may be unfamiliarity with the methods of logit analysis and with computer programs to perform the required calculations.

Therefore, this paper first outlines the logit model and the use of the BMDP4F program (Brown, 1983) to derive an appropriate model. As an example of this method, we then report the results of applying the logit analysis to developing prediction models for the retention and graduation of graduate students at The University of Maryland, College Park (UMCP). (Retention in this report includes graduation as well as continued graduate study.) Finally, the results of the UMCP study are compared with results from other studies.

Logit Analysis

Logit analysis is a method of determining what effects need to be entered into a model for adequately predicting the value of a categorical dependent variable, such as retention. Such a model involves independent variables that are all categorical. The analysis may be viewed as that of a multidimensional contingency table. The statistic commonly used in testing a logit model is the likelihood ratio chi-square ($\underline{L}^2$). In its simplest form, $\underline{L}^2 = 2\sum n_i \log (n_i/m_i)$, where m_i = is the expected value in cell i under the proposed model and n_i is the actual value in the cell (Haberman). If the probability of obtaining a value of $\underline{L}^2$ for a model is not statistically significant, one may conclude that the model provides an adequate fit to the data. The resultant model is called the logit model. Instead of analyzing the dichotomous retention variable, the logit model analyzes a new variable,

the logit ω, which is a logarithmic function[3] of the probability of retention $p_{1 \cdot i}$.

$$\omega_i = \log\left(\frac{p_{1 \cdot i}}{1 - p_{1 \cdot i}}\right).$$

For a logit analysis with three independent variables A, B, C, and dependent variable D, the probability of retention equals

$$p_{1 \cdot ijk} = 1/(1 + e^{-\omega_{ijk}}). \qquad (1)$$

For an analysis with three independent variables, the most complete (saturated) model for the logit may be defined as follows:

$$\omega_{ijk}(1) = 2\,(\lambda_1^{D} + \lambda_{i1}^{AD} + \lambda_{j1}^{BD} + \lambda_{k1}^{CD} + \lambda_{ij1}^{ABD} + \lambda_{ik1}^{ACD} + \lambda_{jk1}^{BCD} + \lambda_{ijk1}^{ABCD}). \qquad (2)$$

Thus the logit is the sum of terms corresponding to the dependent variable and the interactions between the dependent variable and the independent variables.

In logit analysis, one generally begins with a saturated model in which all of these terms are entered. In order to reduce the number of effects, one deletes terms one by one as long as the probability level of the likelihood ratio statistic (L^2) of the resultant model is still greater than .05.[4] Generally the models that are developed are hierarchical, i.e., lower order terms involving an independent variable or interaction of variables are left in the model if a higher order interaction involving such variables remains in the model, even if the lower order terms are not significant.

Data Analysis

The BMD log-linear analysis procedure P4F (Brown) was used on the UNIVAC 1180 to determine which independent variables and interactions were necessary to adequately predict retention. The BMDP4F procedure for logit analysis starts with a log-linear model containing two categories of effects. The first category includes all of the design variables -- the independent variables and all of their interactions. These terms are never removed from the model because the marginal totals of the independent variables are taken as fixed (Brown; Fienberg, 1980). These effects do not explicitly appear in the logit model. The second category of effects includes the interactions between the dependent variable and the independent variables. The BMDP4F program, operating in a stepwise mode, deletes these effects one at a time, until a model is reached for which the probability level of L^2 is less than .05. The model that may be best for the data is the last model for which the probability level is greater than .05.

Following the identification of the required independent variables and interactions, post hoc analyses were performed to identify the specific effects that were significantly different from zero. In these analyses the multiple t-test procedures described by Goodman (1969) were used, because the tests were post hoc and because a set of effects rather than a single effect was tested. In order to avoid Type I errors (i.e., false rejection of the null hypothesis), the critical value of ± 1.96 for significance at the .05 level was replaced with a larger constant, depending on the number of contrasts. For K independent contrasts, the new critical value equals the absolute value of the (2.5)/K percentile of the standardized normal distribution.

The remainder of this report describes the application of logit analysis to predicting the graduation and retention of graduate students. First the

population and sample are identified. Next the dependent variables and the independent variables are defined. Then prediction models for both the graduation and retention variables are discussed separately for master's and doctoral students. The required independent variables and interactions are identified, as are the significant effects.

Analyses of Retention and of Graduation

There were two major areas of interest in this study--identifying predictors of (1) graduation within a specific number of years since admission (one through five years), and (2) retention each year after entry, originally through five years. In all analyses, the retention variable included all of those who were still retained as well as those who had graduated. Graduation and retention were both defined within the original program and at the original degree level. Students who changed programs or changed degree levels without first receiving a degree were considered not retained and not graduated in the year in which the change was made and for all subsequent years.

For master's and doctoral students, retention rates (including those who graduated as retained) were very high through the fifth year of graduate study, partly because registration is not required every term. For master's degree students, admission ordinarily terminates five years from the date of entry if no degree is awarded before five years elapse. Doctoral students must be admitted to candidacy within five years after entrance and complete all remaining requirements within four years after admission to candidacy or their admission is terminated.

Because of these administrative arrangements, many students who appear to be retained through five years after entry are actually not active. On the other hand, many of those who do not register for a number of terms actually complete their degrees. Thus it would be inaccurate to consider such students

as not retained. It is not possible to determine whether each student is active or not until the beginning of the sixth year after entry, at which time the registration of each master's student and each doctoral student who has not been admitted to candidacy is automatically cancelled unless an extension is requested and granted. The effect of these arrangements on the proportions retained is clearly visible in Table 1, which includes data for those students who entered in 1977-78 or 1978-79.

TABLE 1

Proportions Retained by Year After Entry and Level

(1977-78 and 1978-79 entry-year groups)

		Year after entry					
Degree level	N	1	2	3	4	5	5+
Master's	3,058	.964	.918	.892	.866	.851	.574
Doctoral	1,454	.969	.922	.889	.865	.841	.543

Retention rates remain high at each degree level through the fifth year because students are considered retained unless they change programs or degree levels, withdraw, or have their registration terminated. After the fifth year, retention rates drop from 85 percent to 57 percent for master's students and from 84 percent to 54 percent for doctoral students.[5] Therefore, this study selected retention at the start of the sixth year as the single measure of retention in the analysis. Students who graduate within the first five years at the original degree level and in the original program are also counted as retained. (Of the master's students who were retained, 88.8 percent had graduated; of the doctoral students who were retained, 37.9 percent had graduated.) Only the 1977-78 and 1978-79 entry-year groups have been enrolled long enough to have data for this element.

The numbers of students with useable retention and graduation data in these two entry-year groups are given in Table 2.

TABLE 2

Number of Students by Entry Year and Level

Entry-year group	Master's	Doctoral	Total
1977-78	1,664	721	2,385
1978-79	1,394	733	2,127
Total	3,058	1,454	4,512

Graduation rates for master's and for doctoral students were quite different over the five-year period of interest. Including students in the 1977-78 and 1978-79 entry-year groups, the proportions graduated by the end of each year after entry are given in Table 3.

TABLE 3

Proportions Graduated by Num of Years After Entry and Level

(1977-78 and 1978-79 entry-year groups)

		Year after entry				
Degree level	N	1	2	3	4	5
Master's	3,058	.044	.235	.373	.456	.510
Doctoral	1,454	.004	.021	.064	.129	.206

Based on the graduation rates given in Table 3, analyses of predictors of graduation were performed (1) for doctoral students, both four and five years after entry; and (2) for master's students, two through five years after entry. All of these analyses included those who entered in 1977-78 or 1978-79.

Method

Population and Sample

The population consists of all UMCP graduate students who are new registrants for master's or doctoral programs. The sample includes all members of the population who entered in summer, fall or spring of 1977-78 or of 1978-79 -- two entry years. These groups were selected because they are the most recent entry groups that could have completed five years since entry. The total number of new registrants was 3,120 for master's programs and 1,467 for doctoral programs. Data were obtained from the active and/or archived computer files for each of these students. A large number of data elements (including historical enrollment and degree data) were required to determine whether students were retained or had graduated in a given year since entry.

A Fortran program was developed in order to determine, for each year after entry, whether a student was retained in a given program at a given degree level or had graduated at that degree level. This program determined the retention and graduation status for all but 156 (5.0%) of the master's students and 119 (8.1%) of the doctoral students in the sample. Inspection of individual cases reduced the number for which retention and graduation could not be determined to 62 (2.0%) for master's students and to 13 (0.9%) for doctoral students. These cases were omitted in subsequent analyses, resulting in a sample of 3,058 master's students and 1,454 doctoral students.

Dependent Variables

This study involved a series of logit analyses, each with a different dependent variable. For the reasons stated earlier, retention at the start of the sixth year was the single measure of retention. Students who graduated within the first five years at the original degree level and in the original program were also counted as retained. Retention at the start of the sixth

year was the first of the dependent variables in the analysis. Retention will be identified by the symbol R.

The other dependent variables were graduation variables. We analyzed predictors of graduation within four time periods: two, three, four, and five years after entry. The variables are labeled G2, G3, G4, and G5, respectively. Note that graduation within a given number of years after entry (e.g., G4, graduation within four years after entry) includes all those who graduated in that year as well as all those who graduated in prior years (i.e., the first, second, and third years after entry). At the master's level, we analyzed predictors of four graduation variables, G2 through G5. At the doctor's level, we analyzed predictors of two graduation variables, G4 and G5.

Independent Variables

There are many variables which could be included in a graduate retention study. Tinto's complex model (Tinto, 1975) for dropout from undergraduate education includes such constructs as goal commitment, social integration, academic integration, and institutional characteristics, among others. Whereas subsequent studies (e.g., those by Terenzini and Pascarella (1977, 1978)) have tested the relative importance of such constructs, we were interested in assessing the predictive potential of certain variables which are determined by the time of entry into graduate school. Thus, certain variables of interest to Terenzini and Pascarella (1977), such as grade point average, were not appropriate for the current study. On the other hand, the variables of interest in this study are related to Tinto's model. Sex, race/visa status, age, and registration status at entry are all variables which may affect social integration. Registration status at entry may also be an indicator of the level of goal commitment of the student. Academic

division is an institutional characteristic. Although Terenzini and Pascarella (1978) did not find such prematriculation characteristics to be useful in predicting voluntary withdrawal after one year in a private college, we chose these variables either because they are important demographic variables (sex, race, and age) or because they individually appeared to be related to retention if one did not control for the other variables (i.e., academic division and registration status at entry).

The independent variables and their categories were the following:

1. Academic division at The University of Maryland, College Park (see Appendix A)
   a. ALSC -- Division of Agricultural and Life Sciences
   b. MPSE -- Division of Mathematical and Physical Sciences and Engineering
   c. BSOS -- Division of Behavioral and Social Sciences
   d. A & H -- Division of Arts and Humanities
   e. HUCR -- Division of Human and Community Resources
2. Registration status at entry
   a. Full-time entrant (i.e., at least 48 units per semester or 24 units plus a graduate assistantship)
   b. Part-time or summer entrant
3. Sex
   a. Male
   b. Female
4. Age at entry (dichotomized at the median age)[6]
   a. For master's level, 25 or younger vs. 26 or older
   b. For doctoral level, 28 or younger vs. 29 or older
5. Race/visa status
   a. U.S. citizen, refugee or immigrant: White

b. U.S. citizen, refugee or immigrant: Black

c. U.S. citizen, refugee or immigrant: Other (primarily Asian American and Hispanic)

d. Not U.S. citizen, refugee or immigrant (i.e., Foreign)

Registrants in Master's Programs

For the analysis of the retention and graduation of registrants in master's programs, only those students with valid race/visa, sex, age, and academic division codes were included. Primarily because of missing values for race for U.S. students, the sample was reduced from 3,058 to 2,788 (91.2%). Overall, 1,070 (38.4%) of the students in the sample were full-time students at entry, 1,718 (61.6%) were part-time students at entry or entered during the summer. The plurality of students (41.6%) were enrolled in HUCR. Among the other divisions, 10.8 percent of the students were enrolled in ALSC, 14.0 percent in MPSE, 18.5 percent in BSOS, and 15.1 percent in A & H. Most of the students were U.S. Whites (86.3%). U.S. Blacks constituted 5.2 percent of the students; other U.S. students were 3.5 percent. Foreign students comprised 5.0 percent of the master's students.

The proportion of women students (55.7%) exceeded the proportion of men students (44.3%). However, the majority of foreign students were males (62.6%). The number of part-time students exceeded the number of full-time students in every race-by-sex category except foreign males, of whom 67.8 percent were full-time students.

Finally, 50.4% of the students were 25 years old or younger at entry. Of the students who were 25 years old or younger at entry, 49.1 percent were full-time students at entry. Of those who were older than 25 at entry, only 27.5 percent were full-time students at entry. Thus older students were more likely than younger students to be part-time students at entry. See Appendix B for a tabulation of additional student characteristics.

Retention of Master's Degree Registrants

The retention of students who entered graduate school to obtain a master's degree in 1977-78 or 1978-79 was analyzed using logit analysis. Despite the large sample size, it was not possible to enter all of the independent variables into the logit model simultaneously. Although the average number of cases per cell was 8.7 (there were 2,788 cases and 320 cells), the cases were very unevenly distributed among the race/visa groups, with Whites comprising 86.3% of the registrants at the master's level. Entering race/visa status as a variable in the logit analysis along with the other four independent variables led to a large number of sparse or zero cells, and thus to nonconvergence of the log-linear algorithm.

A stepwise approach was used to create a model for retention incorporating race/visa status as a possible variable. The first step of the logit analysis omitted race/visa status as a variable. A suitable model was obtained to predict the probability of retention of master's students regardless of race/visa status, as will be described below. This model incorporated only two independent variables and their interaction. The second step of the analysis included these two independent variables as well as race/visa status in the model to predict retention. This stepwise procedure is conceptually similar to a stepwise solution of a regression problem, entering one set of variables on the first step, removing those that do not contribute significantly to the prediction, and then entering race/visa status as a variable.

Step 1 In order to obtain the model to describe the retention of students without considering race/visa status as a factor, a model was obtained for the two entry-year groups combined (1977-78 and 1978-79). It was possible to model the data using only two of the independent variables, academic division and registration status at entry, and their interaction.

Sex and age and all of the interactions involving these variables were not significant predictors of retention for master's students.

Step 2 Having selected the reduced set of two independent variables, and consequently having reduced the number of cells in the table to 20, the independent variable race/visa status was entered into the model for retention. The "best" model that was obtained included each of the three remaining independent variables (academic division, registration status at entry, race/visa status), as well as the interactions between academic division and registration status at entry and between academic division and race/visa status.[7] The observed frequencies and the percentages retained are given in Table 4.

Following the identification of the required independent variables and interactions, a post hoc analysis of effects was conducted to identify statistically significant effects ($p < .05$). The results of the post hoc analysis are as follows:

Academic division -- No effects are significant.

Registration status -- Predicted retention rates (see Table 5) are higher for those who are full-time students at entry into master's programs than for those who are part-time students at entry. (Of full-time students, 70.8 percent were retained; 50.3 percent of part-time students were retained. The majority (61.6%) of students in the sample were part-time students at entry.)

Race/visa status -- None of the effects differs significantly from zero. However the foreign student effect approached significance. In future studies it would be worthwhile to determine whether the predicted retention rate of foreign students is larger than that of U.S. students.

Academic division by registration status -- None of these interaction effects differs significantly from zero, although the effect for full-time versus

TABLE 4

Observed Frequencies of Master's Students, Categorized by Retention Status, Race/Visa Status, Registration Status at Entry, and Academic Division

Race/Visa Status	Registration Status	Academic Division	Retention Status 0 (No)	1 (Yes)	Total	Percentage Retained
U.S. White	Full-time	ALSC	52	73	125	58.4%
		MPSE	29	74	103	71.8
		BSOS	51	156	207	75.4
		A & H	60	110	170	64.7
		HUCR	64	220	284	77.5
		Total	256	633	889	71.2
	Part-time	ALSC	67	69	136	50.7
		MPSE	133	75	208	36.1
		BSOS	118	124	242	51.2
		A & H	106	95	201	47.3
		HUCR	332	398	730	54.5
		Total	756	761	1,517	50.2
U.S. Black	Full-time	ALSC	0	1	1	100.0
		MPSE	2	1	3	33.3
		BSOS	8	11	19	57.9
		A & H	2	2	4	50.0
		HUCR	12	18	30	60.0
		Total	24	33	57	57.9
	Part-time	ALSC	4	4	8	50.0
		MPSE	1	2	3	66.7
		BSOS	15	5	20	25.0
		A & H	4	6	10	60.0
		HUCR	21	26	47	55.3
		Total	45	43	88	48.9
U.S. Other	Full-time	ALSC	3	3	6	50.0%
		MPSE	6	6	12	50.0
		BSOS	2	2	4	50.0
		A & H	1	7	8	87.5
		HUCR	3	7	10	70.0
		Total	15	25	40	62.5
	Part-time	ALSC	3	2	5	40.0
		MPSE	10	8	18	44.4
		BSOS	1	6	7	85.7
		A & H	4	1	5	20.0
		HUCR	13	10	23	43.5
		Total	31	27	58	46.6

(table continues)

TABLE 4 (Cont'd)

Race/Visa Status	Registration Status	Academic Division	Retention Status 0 (No)	Retention Status 1 (Yes)	Total	Percentage Retained
Foreign	Full-time	ALSC	1	10	11	90.0
		MPSE	5	21	26	80.8
		BSOS	2	8	10	80.0
		A & H	7	8	15	53.3
		HUCR	2	20	22	90.9
		Total	17	67	84	79.8
	Part-time	ALSC	1	8	9	88.9
		MPSE	7	9	16	56.2
		BSOS	5	1	6	16.7
		A & H	3	6	9	66.7
		HUCR	6	9	15	60.0
		Total	22	33	55	60.0

TABLE 5

Predicted Retention Rates for Master's Students, by Academic Division, Race/Visa Status, and Registration Status

Academic Division	Full-time				Part-time			
	U.S. White	U.S. Black	U.S. Other	Foreign	U.S. White	U.S. Black	U.S. Other	Foreign
ALSC	58.8%	62.7%	49.3%	91.4%	50.5%	54.6%	41.0%	88.3%
MPSE	68.8	65.7	65.6	81.7	37.5	34.3	34.1	54.7
BSOS	75.7	54.3	85.1	66.3	50.9	28.4	65.6	39.6
A & H	64.2	68.6	67.8	64.6	47.7	52.5	51.6	48.0
HUCR	76.7	71.5	68.4	85.3	54.7	47.9	44.2	68.1

part-time students in ALSC approaches significance. If significant, this effect would indicate that entering a master's program as a part-time student is less of a disadvantage in ALSC than in the other divisions.

Academic division by race/visa status -- These effects were too small to be statistically significant in a post hoc analysis.

Graduation of Master's Degree Registrants We analyzed each of the graduation variables separately (i.e., G2, G3, G4, G5). In the first step of each graduation analysis we entered academic division, registration status, age, and sex as independent variables, and the respective graduation variable as the dependent variable. For predicting graduation within two, three, four, or five years after entry (G2, G3, G4, or G5), age and all of its interactions did not enter the models; these terms were removed from the analyses. An attempt was then made to incorporate race/visa status as an independent variable in the analyses of the graduation variables; however, this was not possible because of the large numbers of zero cells that resulted when race/visa status was entered. There were more zero cells for the graduation analyses than for retention because fewer students were graduated then were graduated or still enrolled (i.e., retained).

The actual form of the logit models differed somewhat among the graduation variables for graduation within two through five years of entry (G2 through G5). However, each model for graduation included at most three independent variables (academic division, registration status at entry, and sex), and interactions involving these variables. Age and any interactions involving age were not required to model the graduation variables. The results of the analyses for predicting graduation at the master's level are summarized in Table 6 in terms of the independent variables and the interactions that were required in the models. Note that all effects

TABLE 6

Summary of Required Independent Variables and Interactions for Graduation and Retention Models at the Master's Level

Independent Variables and Interactions	Dependent Variables				
	G2	G3	G4	G5	R
Registration Status	***	***	***	***	***
Academic Division	***	***	***	***	***
Sex	**	**		**	
Academic Division by Registration Status		***	***		*
Academic Division by Sex	***	***		*	

*Required in model so that probability level of model $p > .05$.

**Required so that academic division by sex interaction can enter.

***Required in model, and one or more effects were significant in post hoc analyses.

identified as significant were tested using adjusted significance levels because these are post hoc analyses. The probability level was $p < .05$.

The results of the post hoc analyses of effects are as follows:

Academic division -- For each graduation variable (G2 through G5), predicted graduation rates were higher in BSOS and in HUCR than the average. For graduation within two years of entry (G2), predicted graduation rates were lower in ALSC than the average. For graduation within four years of entry (G4), predicted rates were lower in A & H than the average.

Registration status -- For each graduation variable (G2 through G5), predicted graduation rates were significantly higher for students who were full time rather than part time at entry. Two years after entry, few students who were part time at entry had graduated; five years after entry, those who had been full time at entry still maintained a significant advantage in graduation rates. (See Table 7.)

Academic division by registration status -- This interaction was required in the models for graduation within three and four years of entry (G3 and G4) but not for graduation within two or five years of entry (G2 or G5). Three years after entry (G3), full-time status at entry was less of an advantage in ALSC than in the other divisions. Four years after entry (G4), full-time status at entry was a greater advantage in MPSE than in the other divisions.

Sex -- This independent variable was included in the logit models for graduation within two, three, and five years after entry (G2, G3, G5) because an academic-division-by-sex interaction was required to adequately model these variables. However, there was no significant sex effect.

Academic division by sex -- This interaction was required in the models for graduation within two, three, and five years after entry (G2, G3, G5).

TABLE 7

Observed Graduation Frequencies and Rates for 1977-78 and 1978-79 Entry-Year Groups

Sex	Registration Status	Academic Division	Number graduated within: 2 years	3 years	4 years	5 years	Total Entrants	Percentages graduated within: 2 years	3 years	4 years	5 years
Male	Full-time	ALSC	11	31	43	45	90	12.2%	34.4%	47.8%	50.0%
		MPSE	62	74	84	86	125	49.6	59.2	67.2	68.8
		BSOS	58	70	77	82	124	46.8	56.5	62.1	66.1
		A & H	23	42	47	52	90	25.6	46.7	52.2	57.8
		HUCR	42	51	58	60	89	47.2	57.3	65.2	67.4
		Total	196	268	309	325	518	37.8	51.7	59.7	62.7
	Part-time	ALSC	4	24	31	37	89	4.5	27.0	34.8	41.6
		MPSE	27	44	54	69	195	13.8	22.6	27.7	35.4
		BSOS	28	48	68	83	168	16.7	28.6	40.5	49.4
		A & H	8	19	25	31	83	9.6	22.9	30.1	37.3
		HUCR	21	38	56	68	183	11.5	20.8	30.6	37.2
		Total	88	173	234	288	718	12.3	24.1	32.6	40.1
Female	Full-time	ALSC	9	19	31	33	53	17.0	35.8	58.5	62.3
		MPSE	3	8	12	12	19	15.8	42.1	63.2	63.2
		BSOS	63	73	84	87	116	54.3	62.9	72.4	75.0
		A & H	31	47	59	63	107	29.0	43.9	55.1	58.9
		HUCR	137	170	179	193	257	53.3	66.1	69.6	75.1
		Total	243	317	365	388	552	44.0	57.4	66.1	70.3
	Part-time	ALSC	2	17	26	29	69	2.9	24.6	37.7	42.0
		MPSE	2	5	8	12	50	4.0	10.0	16.0	24.0
		BSOS	16	25	39	41	107	15.0	23.4	36.4	38.3
		A & H	14	32	38	50	142	9.9	22.5	26.8	35.2
		HUCR	92	204	259	304	632	14.6	32.3	41.0	48.1
		Total	126	283	370	436	1,000	12.6	28.3	37.0	43.6

The only significant effects identified in the post hoc analyses were (1) that predicted graduation rates were lower for females than for males in MPSE two years after entry (G2), and (2) that predicted graduation rates were higher for females than for males in HUCR three years after entry (G3).

Comparison of Graduation and Retention Models for Master's Registrants

In order to compare the graduation and the retention models for master's students, we used the retention model obtained before race/visa status was entered in the model. The factors that enter this retention model are registration status at entry, academic division, and the interaction between these variables.

As was true for all of the graduation variables, retention rates (including those who graduated as retained) were highly related to registration status at entry. Once again full-time students were far more likely to be retained than were part-time students. (See Table 8.) However, a larger proportion of students who were part time at entry than of those who were full time at entry were still enrolled at the start of the sixth year after entry (8.1% versus 4.2%).

Among the academic divisions, predicted retention and graduation rates for HUCR were greater than the average. Although the graduation rates for BSOS had been consistently higher than the average for each graduation variable, predicted retention rates were not significantly higher in BSOS. This difference in results appears to be caused by the relatively low proportions of students still enrolled in BSOS at the start of the sixth year after entry (see Table 8). Neither of the academic-division-by-registration-status interaction effects, which were included in the models for the graduation variables for three and four years after entry (G3 and G4), was

TABLE 8

Status of Master's Students at Start of Sixth Year After Entry

Sex	Registration Status	Division	Numbers			Total Entrants	Percentages		
			Graduated	Enrolled	Retained		Graduated	Enrolled	Retained
Male	Full-time	ALSC	45	7	52	90	50.0%	7.8%	57.8%
		MPSE	86	4	90	125	68.8	3.2	72.0
		BSOS	82	6	88	124	66.1	4.8	71.0
		A & H	52	6	58	90	57.8	6.7	64.4
		HUCR	60	4	64	89	67.4	4.5	71.9
		Total	325	27	352	518	62.7	5.2	68.0
	Part-time	ALSC	37	15	52	89	41.6	16.9	58.4
		MPSE	69	10	79	195	35.4	5.1	40.5
		BSOS	83	4	87	168	49.4	2.4	51.8
		A & H	31	7	38	83	37.3	8.4	45.8
		HUCR	68	20	88	183	37.2	10.9	48.1
		Total	288	56	344	718	40.1	7.8	47.9
Female	Full time	ALSC	33	2	35	53	62.3	3.8	66.0
		MPSE	12	0	12	19	63.2	0.0	63.2
		BSOS	87	2	89	116	75.0	1.7	76.7
		A & H	63	6	69	107	58.9	5.6	64.5
		HUCR	193	8	201	257	75.1	3.1	78.2
		Total	388	18	406	552	70.3	3.3	73.6
	Part-time	ALSC	29	2	31	69	42.0	2.9	44.9
		MPSE	12	3	15	50	24.0	6.0	30.0
		BSOS	41	8	49	107	38.3	7.5	45.8
		A & H	50	20	70	142	35.2	14.1	49.3
		HUCR	304	51	355	632	48.1	8.1	56.2
		Total	436	84	520	1,000	43.6	8.4	52.0

found to be significant in the post hoc analysis of effects related to retention.

Sex and the academic-division-by-sex interaction were not required to describe retention of master's students although they were required in the models for graduation two, three, and five years after entry (G2, G3, and G5). Furthermore, the interaction effect that was found five years after entry was not large enough to be significant in the post hoc analysis. Apparently these academic-division-by-sex interactions were transitory.

Registrants in Doctoral Programs

The total number of students in the sample who were newly enrolled in doctoral programs in 1977-78 or 1978-79 was 1,349. (The sample was reduced from 1,454 to 1,349 (92.8%) because of missing data.) Overall, 693 (51.4%) were full-time students at entry; 656 (48.6%) were part-time students at entry or entered during the summer. Men comprised 58.6 percent of the students, women 41.4 percent.

Among race/visa groups, the largest group (80.5%) was comprised of U.S. Whites. U.S. Blacks were 6.6 percent of the sample; other U.S. racial groups were 4.1 percent of the sample. Foreign students comprised 8.8 percent of the sample.

Among the divisions, 36.5 percent of the students were enrolled in HUCR, 11.9 percent in ALSC, 20.1 percent in MPSE, 19.3 percent in BSOS and 12.1 percent in A & ".

Among the students, 49.2 percent were 28 years old or younger at entry. Of the students who were 28 years old or younger, 66.9 percent were full-time students at entry; of those who were older than 28, 36.4 percent were full-time students at entry. Thus younger students were more likely to be full-time students than were older students. See Appendix B for a tabulation of additional student characteristics.

Retention of Doctoral Degree Registrants

Logit analysis was also used to analyze the retention of students who entered graduate school to obtain a doctoral degree in 1977-78 or 1978-79. (Frequencies and retention rates are given in Table 9.) The same stepwise approach was used for the doctoral retention analysis as for the master's retention analysis described above. The results of this process are as follows:

Step 1 Using all doctoral students, it was possible to model the data using three of the independent variables -- academic division, registration status at entry, sex, and interactions between academic division and sex and between academic division and registration status. Age and all of the interactions involving age are not significant predictors of retention.

Step 2 Having selected the reduced set of three independent variables, and thereby having reduced the number of cells in the table to 40, the independent variable race/visa status was entered into the model. The model that best fit the data does not include race/visa status,[8] but is the same as that before race was entered. The model to predict the probability of retention at the doctoral level includes academic division, registration status at entry, sex, and interactions between academic division and sex and between academic division and registration status.

The post hoc analysis of effects indicated that the following effects were significant at the .05 level:

Academic division -- Predicted retention rates are lower than the average in in MPSE, and greater than the average in HUCR. (See Table 10.)

Registration status -- Predicted retention rates are higher for those who are full-time students at entry into doctoral programs than for those who are part-time students at entry. (Of full-time students, 63.9 percent were retained; 48.0 percent of part-time students were retained.)

TABLE 9

Observed Frequencies of Doctoral Students, Categorized by Retention Status, Sex, Registration Status at Entry, and Academic Division

Sex	Registration Status	Academic Division	Retention Status 0 (No)	Retention Status 1 (Yes)	Total	Percentage Retained
Male	Full-time	ALSC	32	42	74	56.8%
		MPSE	57	92	149	61.7
		BSOS	33	64	97	66.0
		A & H	22	17	39	43.6
		HUCR	20	53	73	72.6
		Total	164	268	432	62.0
	Part-time	ALSC	12	18	30	60.0
		MPSE	56	36	92	39.1
		BSOS	44	20	64	31.2
		A & H	13	14	27	51.9
		HUCR	80	66	146	45.2
		Total	205	154	359	42.9
Female	Full-time	ALSC	19	18	37	48.6
		MPSE	10	5	15	33.3
		BSOS	21	57	78	73.1
		A & H	17	29	46	63.0
		HUCR	19	66	85	77.6
		Total	86	175	261	67.0
	Part-time	ALSC	14	6	20	30.0
		MPSE	13	2	15	13.3
		BSOS	6	16	22	72.7
		A & H	19	32	51	62.7
		HUCR	84	105	189	55.6
		Total	136	161	297	54.2

TABLE 10

Predicted Retention Rates for Doctoral Students,

by Academic Division, Sex, and Registration Status

Division	Males		Females	
	Full-time	Part-time	Full-time	Part-time
ALSC	59.2%	54.1%	43.9%	38.9%
MPSE	62.0	38.8	31.5	15.2
BSOS	62.1	37.1	77.9	55.8
A & H	45.7	48.9	61.3	64.4
HUCR	71.5	45.7	78.6	55.2

Academic division by registration status -- Although this interaction entered the model, none of the individual effects was significant in the post hoc analysis.

Academic division by sex -- Predicted retention rates differed by sex within two divisions, MPSE and BSOS. Predicted retention rates were greater for males than for females in MPSE, and greater for females than for males in BSOS. When combined with the lower predicted retention rate for all students in MPSE, the predicted retention rate is very low for women in this division. (See Table 10.) Conversely, the predicted retention rate is quite high for women in BSOS. Although there is no overall sex difference in predicted retention rates, within these divisions there are large sex differences in predicted retention rates.

Graduation of Doctoral Degree Registrants

At the doctoral level, two graduation variables were analyzed, graduation within four years of entry (G4) and graduation within five years of entry (G5). Once again, in the first step of each analysis academic division, registration status, age, and sex were the independent variables, and the respective graduation variable was the dependent variable. For predicting graduation within four or five years after entry (G4 or G5), sex and all of its interactions did not enter the models; these terms were removed from the analysis. It was not possible to incorporate race/visa status as an independent variable in the analyses of the graduation variables, because of the large numbers of zero cells that resulted. Note that variables were being analyzed such that only 12.6 percent of the students had graduated within four years of entry, and 20.8 percent had graduated within five years of entry.

The logit models for graduation within four or five years of entry (G4 and G5) were very similar. As stated above, sex was not included in the logit models. However, the models included an interaction among academic division,

registration status, and age. Consequently, each of these variables and each of the interactions involving pairs of these variables had to be included in the logit model.

Post hoc analyses of the effects indicated that the following effects were significant at the .05 level:

Academic division -- Predicted graduation rates, both within four and within five years of entry (G4 and G5), were significantly higher in ALSC and in HUCR than the average.

Registration status -- Predicted graduation rates were significantly higher for students who were full time at entry than for those who were part time at entry. After four years (G4), 15.7 percent of full-time and 9.3 percent of part-time students had graduated. After five years (G5), 26.7 percent of full-time and 14.5 percent of part-time students had graduated.

Academic division by registration status by age -- This complex interaction was required in the logit model for each graduation variable (G4 and G5). However, none of the effects was significant in the post hoc analyses. The effect that came closest to reaching significance was an effect within MPSE. In MPSE, for students who were 28 years old or younger, those who were part-time students at entry had a higher graduation rate than did full-time students; students who were older than 28 years of age at entry followed the usual pattern in which those who were full-time students at entry had higher graduation rates than those attained by part-time students.

Thus the major results concerning graduation rates were that (1) predicted graduation rates after four or five years (G4 and G5) were higher in ALSC and HUCR than in general, and (2) students who were full-time

students at entry were more likely to have graduated than students who were part time at entry.

Comparison of Graduation and Retention Models for Doctoral Students

Neither the logit models for retention nor for graduation of doctoral students included race/visa status. Thus it was possible to compare these models directly. In the retention and the graduation models, registration status at entry and academic division were required. The post hoc analyses indicated that students who were full time at entry were significantly more likely to have graduated and to be retained (retention includes those who have graduated) than were part-time students. (See Table 11.) Of the students who were initially enrolled, 35.4 percent were still enrolled at the start of the sixth year after entry. Among those who were full-time students at entry, 37.2 percent were still enrolled; among those who were part-time students at entry, 33.5 percent were still enrolled.

With respect to differential effects among academic divisions, graduation rates five years after entry were significantly higher than the average in ALSC and in HUCR. (See Table 11.) Retention rates were higher than the average in HUCR and lower than the average in MPSE. The retention rates were not unusually high for ALSC despite the high graduation rates in ALSC because the proportions still enrolled were low in this academic division. The retention rates were low for MPSE, although the graduation rates were average, largely because of the low proportions of women students and of men part-time students who were still enrolled at the start of the sixth year after entry.

There was an academic-division-by-sex interaction required in the model for retention that was not required for the graduation analyses. Predicted retention rates were greater for males than for females in MPSE, and greater for females than for males in BSOS. As indicated in Table 11, this effect in BSOS clearly is the result of the larger proportions of women than of men who

TABLE 11

Status of Doctoral Students at Start of Sixth Year After Entry

Sex	Registration Status	Division	Numbers			Total Entrants	Percentages		
			Graduated	Enrolled	Retained		Graduated	Enrolled	Retained
Male	Full-time	ALSC	31	11	42	74	41.9%	14.9%	56.8%
		MPSE	25	67	92	149	16.8	45.0	61.7
		BSOS	21	43	64	97	21.6	44.3	66.0
		A & H	6	11	17	39	15.4	28.2	43.6
		HUCR	34	19	53	73	46.6	26.0	72.6
		Total	117	151	268	432	27.1	35.0	62.0
	Part-time	ALSC	10	8	18	30	33.3	26.7	60.0
		MPSE	18	18	36	92	19.6	19.6	39.1
		BSOS	3	17	20	64	4.7	26.6	31.2
		A & H	3	11	14	27	11.1	40.7	51.9
		HUCR	17	49	66	146	11.6	33.6	45.2
		Total	51	103	154	359	14.2	28.7	42.9
Female	Full-time	ALSC	10	8	18	37	27.0	21.6	48.6
		MPSE	3	2	5	15	20.0	13.3	33.3
		BSOS	16	41	57	78	20.5	52.6	73.1
		A & H	7	22	29	46	15.2	47.8	63.0
		HUCR	32	34	66	85	37.6	40.0	77.6
		Total	68	107	175	261	26.1	41.0	67.0
	Part-time	ALSC	4	2	6	20	20.0	10.0	30.0
		MPSE	1	1	2	15	6.7	6.7	13.3
		BSOS	1	15	16	22	4.5	68.2	72.7
		A & H	6	26	32	51	11.8	51.0	62.7
		HUCR	32	73	105	189	16.9	38.6	55.6
		Total	44	117	161	297	14.8	39.4	54.2

were still enrolled, both among full-time and part-time students. The effect in MPSE is largely the result of differences in proportions of men and women who were still enrolled. Because the academic-division-by-sex interaction was the result of different proportions still enrolled, rather than different proportions graduated, the interaction was not required in the graduation analysis.

Finally, the academic-division-by-age-by-registration-status interaction that entered into the models for graduation did not enter into the model for retention of doctoral students.

Summary

The Office of Institutional Studies at UMCP conducted a study of the retention and graduation of students in master's or doctoral programs. The study involved a major data collection effort, drawing on UMCP computerized data files. Data were obtained for all entrants into master's or doctoral programs who first enrolled in these programs from May 1977 through January 1982 (7,613 master's students; 3,807 doctoral students). Retention and graduation each year after entry could be determined for 98.6 percent of master's students and 98.9 percent of doctoral students.

Retention rates (including those who graduated as retained) were very high through the fifth year after entry (about 85 percent), but dropped substantially at the start of the sixth year to about 55 percent. The reason for the sharp decline is that the registration of master's students who have not completed their degrees and doctoral students who have not passed their candidacy exams is cancelled at the start of the sixth year, unless an extension is requested and granted. Many inactive students are included among the "retained" students prior to the start of the sixth year. However, it is possible for these students to return and complete their degrees after a period of inactivity, so that they must be considered retained unless proved otherwise. Therefore, this study selected retention at the start of the sixth year after entry as the single measure of retention.

The proportions graduated within one through five years after entry differed for master's and for doctoral students, with 23.5 percent of master's students graduating within two years of entry, and 12.9 percent of doctoral students graduating within four years of entry. The graduation variables that were analyzed were graduation within two, three, four or five years of entry for master's students, and graduation within four or five years of entry for

doctoral students. The only entry-year groups that entered early enough to have completed five years since entry were those that entered in 1977-78 or 1978-79. These students were taken as the sample for this analysis (3,058 master's students, 1,454 doctoral students).

The data analysis procedure was logit analysis, a method of analyzing multidimensional tables in order to determine which independent variables and interactions are required to describe a categorical dependent variable. For the logit analysis, the BMDP4F log-linear analysis procedure was used on the UNIVAC 1180 at the UMCP Computer Science Center. Following the identification of the required independent variables and interactions for each dependent variable, post hoc analyses (with adjusted significance levels) were performed to identify the specific effects that were significantly different from zero.

The dependent variables that were analyzed were retention at the start of the sixth year (separately for master's and doctoral students), graduation within two, three, four or five years of entry (for master's students), and graduation within four or five years of entry (for doctoral students). The independent variables that were included in the analyses were academic division at UMCP, registration status at entry (full time or part time/ summer), sex, age at entry (dichotomized at the median age), and race/visa status. For technical reasons, race/visa status could only be entered into the analyses of the retention variable, not of the graduation variables.

For each dependent variable, a logit model was developed that incorporated only those independent variables and interactions that were required to model the data adequately. These analyses were performed separately for master's and for doctoral students.

For the analyses based on data for master's students, the final sample size was 2,788. Age and interactions involving age were not required to model the retention variable or any of the graduation variables. For master's

students, academic division, registration status at entry, race/visa status, and interactions between academic division and registration status and between academic division and race/visa status were required in the model for the retention variable. The effect that was found to be significant (at $p < .05$) in the post hoc analysis was that predicted retention rates were higher for students who are full time at entry than for those who are part time at entry or enter during the summer.

The analyses of the graduation variables for master's students did not include race/visa status because of the large number of sparse or zero cells that were created when race/visa status was entered. The actual form of the logit models differed somewhat among the graduation variables for graduation within two through five years of entry. However, each model for graduation included at most three independent variables (academic division, registration status at entry, and sex), and interactions involving these variables. Sex only entered as a variable because an academic-division-by-sex interaction entered the models for some of the graduation variables. Controlling for the other variables, predicted graduation rates did not differ by sex. The effects that were found to be significant in the post hoc analyses of the graduation variables were as follows:

(1) For each graduation variable (i.e., graduation within two, three, four, or five years of entry), predicted graduation rates were higher in BSOS and in HUCR than the average. For graduation within two years of entry, predicted graduation rates were lower in ALSC than the average. For graduation within four years of entry, predicted rates were lower in A & H than the average.

(2) For each graduation variable, predicted graduation rates were higher for students who were full time rather than part time at entry.

(3) For graduation within three years of entry, full-time status at entry was less of an advantage in ALSC than in the other academic divisions. For graduation within four years of entry, full-time status at entry was a greater advantage in MPSE than in the other academic divisions.

(4) For graduation within two years of entry, predicted rates were lower for females than for males in MPSE. For graduation within three years of entry, predicted graduation rates were higher for females than for males in HUCR.

Differences between the retention results and the graduation results for master's students are primarily caused by differences in proportions of students who were still enrolled at the start of the sixth year after entry.

For the analyses based on data for doctoral students, the final sample size was 1,349. Academic division, registration status at entry, sex, and interactions between academic division and sex and between academic division and registration status were required in the model for the retention variable. Race/visa status was not required in the model. The effects that were significant in the post hoc analysis were as follows:

(1) Predicted retention rates are lower than the average in MPSE, and higher than the average in HUCR.

(2) Predicted retention rates are higher for those who are full-time students at entry into doctoral programs than for those who are part-time students at entry.

(3) Predicted retention rates were greater for males than for females in MPSE and greater for females than for males in BSOS.

This result is an example of two of the benefits of logit analysis compared with chi-square analysis -- identification of interactions among independent variables, and explication of apparent effects. Analysis of the

marginal tables of each independent variable versus retention status (e.g., a set of chi-square analyses) would have indicated a significant association between sex and retention status ($\underline{z}^2 = 6.26$, $\underline{p} = .0062$ (one-tailed)).[9] However, because the logit model introduces interactions among the independent variables, we have identified the important interaction among sex, academic division, and retention status, controlling for registration status. Using the logit model, we found no difference in the overall predicted retention rates of men and women doctoral students.

The analysis of the two graduation variables for doctoral students did not include race/visa status because of the large number of sparse or zero cells that were created when race/visa status was entered. The logit models for graduation within four or five years of entry are very similar. Neither included sex or any interactions incorporating sex. However, the model included an interaction among academic division, registration status at entry, and age. Consequently, each of these variables and each of the interactions involving pairs of these variables had to be included in the logit model. The effects that were found to be significant in the post hoc analyses were as follows:

(1) Predicted graduation rates, both within four and five years of entry, were significantly higher in ALSC and in HUCR than the average.

(2) Predicted graduation rates for graduation within four and five years of entry were higher for students who were full time at entry than for those who were part time at entry.

Once again, differences in the results of the graduation and retention analyses for doctoral students are attributable to differing proportions of students who were still enrolled six years after entry.

Discussion

There is little published data available on the retention of graduate students by race. However, Astin (1982) compared Fall 1976 first-year graduate enrollments by race with 1978-79 master's and doctoral degrees awarded by race. He concluded that the dropout rates for minorities were substantially higher than for Whites. There are a number of problems with his analysis--the three-year period allowed for the award of master's or doctoral degrees was too short; such variables as academic field, full-time versus part-time status, and sex were uncontrolled; and students were not tracked individually. Naylor and Sanford tabulated retention rates by race and (separately) by sex for master's and doctoral students each year after entry. After five years, Whites and others had higher retention rates than Blacks did for master's degrees but this pattern was reversed at the doctoral level. Unfortunately their analysis did not cross-classify the students by sex and by race, or control for academic field or for full-time versus part-time status. Our study did not find any significant difference in the predicted retention rates of U.S. racial groups or for foreign students at either the master's or the doctoral level. However, we found a tendency toward greater retention for foreign students than for U.S. students at the master's level. If such an effect is replicated, it may be related to the fact that foreign students are usually unable to work or even remain in the United States if they drop out of school. This incentive, however, may not operate as strongly for the typically longer course of study involved in obtaining a doctorate. In our study, therefore, race/visa status may be related to retention as a proxy for goal commitment rather than as an indicator of social integration.

In relation to the analysis of retention rates by sex, retention statistics for men and women were compared in a number of studies completed by

the mid 1970's. Those studies reviewed by Solmon (1976) tend to indicate that women had lower retention rates than men did and that retention for all students differed by field of study. In a more recent study, Naylor and Sanford found that women were retained at a higher rate than men for master's degrees and at about the same rate as men for doctoral degrees. However, the latter study did not control for field of study, full-time versus part-time status, and race/visa status. Although our study did not find overall differences in predicted rates of retention by sex, the academic-division-by-sex interaction is quite striking at the doctoral level. The sex of the student may affect the level of social integration that is achieved if, for example, the student is a female in a field whose students and faculty are predominantly males. Thus an academic-division-by-sex interaction is plausible. Terenzini and Pascarella (1978) obtained an interaction among sex, academic program, and retention among college students.

In the current study, the difference in predicted retention rates among academic divisions at the doctoral level may be related to differences in the perceived advantage accruing to the completion of a doctorate versus the personal and financial sacrifice involved in continued study, i.e., to differences in goal commitment. The consistent difference in predicted retention for full-time versus part-time graduate students indicates that this is an important explanatory variable to include in future retention studies. Full-time rather than part-time status at entry may be related to greater goal commitment and may result in a higher degree of social integration. Both of these characteristics would be expected to lead to increased likelihood of persistence, according to Tinto's model. Finally, the lack of a significant relationship between age and retention in graduate school is similar to the conclusion of Pantages and Creedon (1978) for college attrition.

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Notes

1. The problem with the use of discriminant analysis is the failure to meet the requirement of a multivariate normal distribution with equal covariance matrices for each level of the dependent variable. This failure may result in inaccurate predictions for small and large probabilities (Fienberg, 1980). The problem with the use of multiple regression analysis is a loss of power and the fact that the use of the F statistic cannot be justified (Goodman, 1975).

2. The logit model and the probit model give very similar results, but the logit model is slightly more convenient to use in terms of computational difficulty (Haberman, 1978).

3. A logarithmic function of the probability is used rather than the probability itself in order to avoid obtaining estimates of the probability that are outside the allowed range of zero to one (Goodman, 1975).

4. Knoke and Burke (1980) recommend a probability level between .10 and .35 to reduce the danger of Type II errors. However, most logit analyses assume a probability level of .05.

5. Naylor and Sanford report higher percentages retained for master's degrees (76.8%) and similar percentages retained for doctoral degrees (53.6%) after five years at the University of North Carolina at Chapel Hill (UNC-CH). Nevertheless, differing administrative regulations concerning registration at UNC-CH and UMCP make comparisons problematic.

6. Had we used age as a continuous variable, logistic regression rather than logit analysis would have been an appropriate method of analysis. However in attempting to enter the interaction terms into the logistic regression analysis, we exceeded the memory allocated by the BMDPLR program (Engelman, 1983). Therefore we dichotomized age and proceeded with a logit analysis.

7. It is possible that there would have been significant interactions between retention and the independent variables that were removed in Step 1 had race/visa status been entered in the analysis with these variables. Further, this procedure does not allow interaction terms to enter between race/visa status and the variables that were removed in Step 1.

8. In addition to the points in footnote 7, note that race/visa status might have entered as a variable in the case of the retention of doctoral students if the independent variable that was removed in Step 1 (age) was entered at the same time as race/visa status.

9. We have used the $\underline{z}^2$ test for a 2 x 2 table (Darlington, 1975, p. 476).

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APPENDIX A

Graduate Programs, by Academic Division

1) Division of Agricultural and Life Sciences (ALSC)

College of Agriculture Programs:
- Agricultural and Extension Education
- Agricultural and Resource Economics
- Agricultural Engineering
- Agronomy
- Animal Sciences
- Food Science
- Horticulture
- Poultry Science

Other Programs within the Division:
- Biochemistry
- Botany
- Chemistry
- Entomology
- Geology
- Microbiology
- Zoology

2) Division of Mathematical and Physical Sciences and Engineering (MPSE)

College of Engineering Programs:
- Aerospace Engineering
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Engineering Materials
- Mechanical Engineering
- Nuclear Engineering

Other Programs within the Division:
- Applied Mathematics
- Astronomy
- Chemical Physics
- Computer Science
- Mathematical Statistics
- Mathematics
- Meteorology
- Physics

3) Division of Behavioral and Social Sciences (BSOS)

College of Business and Management Program

Other Programs within the Division:
- Criminal Justice and Criminology
- Economics

Geography
Government and Politics
Hearing and Speech Sciences
Policy Studies
Psychology
Sociology
Urban Studies

4) Division of Arts and Humanities (A & H)

School of Architecture Program

College of Journalism Program

Other Programs within the Division:
American Studies Program
Art
Communication Arts and Theatre
Comparative Literature
English Language and Literature
French Language and Literature
German Language and Literature
History
Music
Philosophy
Public Communication
Spanish Language and Literature

5) Division of Human and Community Resources (HUCR)

College of Education Programs:
Counseling and Personnel Services
Early Childhood-Elementary Education
Education Policy, Planning, and Administration
Human Development Education
Industrial Education
Measurement and Statistics
Secondary Education
Special Education

College of Human Ecology Programs:
Family and Community Development
Foods, Nutrition and Institution Administration
Textiles and Consumer Economics

College of Library and Information Services Program

College of Physical Education, Recreation and Health Programs:
Health Education
Physical Education
Recreation

APPENDIX B

Characteristics of Sample by Level of Program

	Master's (N=2,788) N	%	Doctoral (N=1,349) N	%
Initial term of entry				
May 1977	105	3.8%	26	1.9%
July 1977	127	4.6	12	0.9
August 1977	912	32.7	475	35.2
January 1978	411	14.7	168	12.5
May 1978	45	1.6	22	1.6
July 1978	89	3.2	36	2.7
August 1978	687	24.6	422	31.3
January 1979	412	14.8	188	13.9
Year of entry				
1977-78	1,233	44.2	668	49.5
1978-79	1,555	55.8	681	50.5
Registration status at entry				
Full time	1,070	38.4	693	51.4
Part time or summer entrant	1,718	61.6	656	48.6
Sex				
Male	1,236	44.3	791	58.6
Female	1,552	55.7	558	41.4
Citizenship				
U.S. citizen, refugee, or immigrant	2,649	95.0	1,230	91.2
Foreign	139	5.0	119	8.8
Race/visa status				
U.S.: American Indian	18	0.6	5	0.4
Black	145	5.2	89	6.6
Asian American	41	1.5	31	2.3
Hispanic	39	1.4	19	1.4
White	2,406	86.3	1,086	80.5
Foreign	139	5.0	119	8.8
Age at entry				
Less than or equal to 25 (28)	1,404	50.4	664	49.2
Greater than or equal to 25 (28)	1,384	49.6	685	50.8

APPENDIX B (Cont'd)

	Master's (N=2,788)		Doctoral (N=1,349)	
	N	%	N	%
Academic division				
ALSC	301	10.8%	161	11.9%
MPSE	389	14.0	271	20.1
BSOS	515	18.5	261	19.3
A & H	422	15.1	163	12.1
HUCR	1,161	41.6	493	36.5
College or School				
Agriculture	175	6.3	47	3.5
Business and Management	272	9.8	32	2.4
Education	686	24.7	421	31.3
Engineering	216	7.8	77	5.7
Human Ecology	115	4.1	6	0.4
Journalism	47	1.7	0	0.0
Library and Information Services	241	8.7	6	0.4
Physical Education, Recreation and Health	119	4.3	60	4.4
Non-college programs				
ALSC	126	4.5	114	8.5
MPSE	173	6.2	194	14.4
BSOS	243	8.7	229	17.0
A & H	375	13.5	163	12.1
Resident status				
Maryland resident	1,871	67.1	655	48.6
Non-Maryland resident	917	32.9	694	51.4
Graduate assistant first term				
Not a graduate assistant	2,504	89.8	982	72.8
Full-time teaching assistant	268	9.6	345	25.6
Full-time research assistant	7	0.3	6	0.4
Part-time teaching assistant	9	0.3	13	1.0
Part-time research assistant	0	0.0	3	0.2
Previous class, if entered as graduate student in prior three years				
Did not enter earlier	2,547	91.4	1,038	76.9
Master's level	89	3.2	176	13.0
Doctoral level	10	0.4	36	2.7
Nondegree student	142	5.1	99	7.3
Received bachelor's degree from UMCP				
Yes	913	32.7	176	13.0
No	1,875	67.3	1,173	87.0